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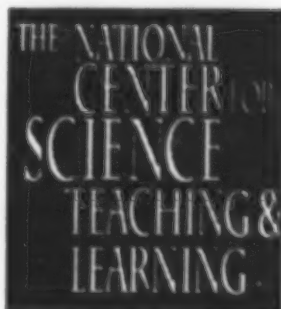
ABSTRACT

The National Center for Science Teaching and Learning (NCSTL) located at The Ohio State University conducts research on factors that while influencing the teaching and learning of science are generally outside teacher control. This NCSTL digest deals with the professional status and responsibility of science teachers in schools. While giving lip-service to teaching as a profession, few have been willing to establish the work environment that would promote and sustain the professional teacher. In this digest, projects of the NCSTL are described that explore the facets of science teacher responsibilities; the barriers that discourage and the resources that contribute to teacher professionalism. (PR)

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Teaching as a Profession

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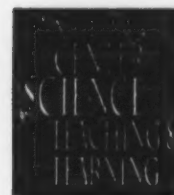
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This Digest was compiled and written by Dr. Arthur L. White, Director, and Dr. Michael H. Klapper, Co-Director, of NCSTL, and edited by Michael Aiello, Program Manager. The content represents the work and input of the entire NCSTL staff, in particular Dr. Donna Berlin, Focus Area 5 Coordinator, and Dr. Philip Heath, Focus Area 2 Coordinator.



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President Bush has declared that by the year 2000, "U.S. students will be first in the world in science and mathematics achievement." However, there are barriers to that goal. The American public has a poor understanding of science and mathematics processes and content. College student interest in mathematics and the sciences has declined dramatically over the past decade. And we have failed to attract more minority and women students, major pools of talent, into mathematics and science. Each of these well documented problems challenge the science education community to consider changes in and even the dramatic restructuring of science education in U.S. schools. We agree with Fowler;¹ each of us has a responsibility to help our children realize, and not squander, their talents and potential.

At the National Center for Science Teaching and Learning (NCSTL) we conduct research on factors that while influencing the teaching and learning of science are generally outside teacher control. Included among these factors, that we call "external", are social and cultural influences, public incentives and perceptions, political and economic forces, the impact of new technologies, and integrated teaching and learning of science and mathematics. Our research into external factors is dedicated to informing the national efforts for the improvement of science teaching and learning and thus for the renewal of our schools.

Purpose of the NCSTL Digest

Our purpose in publishing the NCSTL Digest for teachers, parents, children, and school policy makers is to consider how we all might improve the teaching and learning of science. This issue of the Digest deals with the professional status and responsibilities of science teachers in our schools. While giving lip-service to teaching as a profession, few in the nation have been willing to establish the work environment that would promote and sustain the professional teacher. At the National Center for Science Teaching and Learning we have been exploring: the facets of science teacher responsibilities; the barriers that discourage and the resources that contribute to teacher professionalism.

Teaching as a Profession

Introduction

While our society expects teachers to be professional in fulfilling their responsibilities, we rarely treat them professionally. For example, there is generally insufficient time in the school day for teachers to design new teaching and learning activities. There are insufficient opportunities and incentives to develop the knowledge and skills teachers need for self-inquiry into their teaching methods and strategies. The available support systems and resources (e.g., networks for teachers; space, equipment, facilities, and supplies; flexible scheduling and school structure; and infrastructure for communication with and involvement of administrators, parents, and the community) are inadequate for the meaningful and effective implementation of a curriculum

reform that ultimately must be the responsibility of the teacher. For teachers to effect lasting changes that will update and enrich students' understanding, we in the U.S. must provide teachers with the opportunities to make thoughtful, informed decisions, the flexibility to use resources in more productive and innovative ways, and the incentives for the improvement of performance. We must institutionalize the attitude that a teacher's continual reflection, within the school setting, on the activity in his or her classroom is vital. We must construct avenues for communication, and collaboration among and between teachers, administrators, parents, students, corporate America, policy and decision makers, and the public. And we must provide teachers adequate support as they participate in today's curriculum standard-setting and reform efforts. Without these commitments to our teachers, as professionals, we shall not move toward the goals of true reform and excellence in our schools. Without these commitments we will find today's problems and crises again in the future.

Professional Status of Teachers — NCSTL Research Projects

The NCSTL is involved in three studies that look at the factors influencing the professional status of K-12 science teachers, and that explore enhancing that status. One is a study at an action research program; the other two deal with the development of partnerships between science teachers and university or industry scientists. The next sections provide brief descriptions of these projects with particular attention to those aspects not generally found within the educational setting. We then discuss possible insights gained from this work, explorations of other changes from the traditional, and the lessons teachers, parents, decision-makers, and students might draw from our experiences. For all of us, as members of this society, must constantly observe the school experience so that together we can identify and build upon success while recognizing and correcting failure.

Action Research

One critical challenge for our national educational system is to bridge the gap between research and practice — to ensure that researchers work on problems relevant to practitioners, and that practitioners are aware of useful research findings. In the third edition of the *Handbook of Research on Teaching*, a project of the American Educational Research Association, White and Tisher² noted that while the science education research conducted over the last decade has had little impact on practice, there have nonetheless been research-based advances derived from the collaborative efforts of researchers and practitioners.

Action research involves teachers as integral members of research teams engaged in classroom-based inquiry; teachers as professionals observe in their own classrooms and reflect upon their own practice in order to improve the educational experiences of their students. The action research project supported jointly by the Ohio Board of Regents, The Ohio State University-Newark, and NCSTL was designed to determine:

• how teachers' participation in action research projects influences their professional and personal attitudes and perceptions.

• how teachers' participation in action research projects affect their views on both education research and curriculum and instruction reform efforts.

Also embedded into the project were the specific aims of:

• encouraging and supporting the professional development of teachers.

• encouraging teachers' application of research in the improvement of classroom practice.

• developing and disseminating effective innovative methods and materials that have been classroom-tested through action research.

• promoting collaboration between institutions of higher learning, state educational systems, teachers, and administrators.

• providing collaborative, researcher and practitioner, identification of educational needs, problems, and solutions.

• developing teacher leadership in the implementation, evaluation, and dissemination of innovations in teaching and learning;

• providing teachers knowledge of and experiences in classroom-based research.

In action research projects teachers actively develop, implement, and evaluate new learning experiences for their students and observe their own teaching. However, before assuming the role of leader in an action research project, the teacher must have the opportunity to acquire the appropriate knowledge and skills. These include library search strategies, basic concepts and principles of research design, sampling, measurement, statistical inference, data analysis, and interpretation of data related to both quantitative and qualitative methods. Additionally, opportunities must be available for encouraging, recognizing, and supporting the teacher as a leader in: i) identification of educational problems for research; ii) design of studies; iii) implementation of research plans, iv) data collection; v) data organization and analysis; vi) interpretation of results; and vii) communication and dissemination of research findings.

There are three phases to the Ohio State action research program: pedagogical awareness; research, development, and evaluation concepts and skills; and classroom implementation of innovation and research plans. During the first phase — pedagogical awareness — the participants explore selected innovative practices from current educational trends. Recent topics, for example, have dealt with new science and/or mathematics education curriculum, instruction, and assessment standards. During the second phase — research, development, and evalua-

tion — the participants experience a variety of data sources and collection procedures (e.g., archival records, observations field notes, interviews, artifact collection) and data analysis strategies (e.g., coding, categorizing, inductive analysis, triangulation, data displays, database manipulation, and descriptive narration). During the third phase — classroom implementation — participants design, implement, and analyse their own classroom research plan. Each participant receives ten graduate hours of tuition-free course credit, funds for one-half day of substitute teacher support, expenses to cover a two-day retreat for reporting and reflecting on the results and the experience, resources as needed (e.g., assessment instruments, books, equipment, software, and video tapes/disks), and advice and encouragement from the university researchers and staff.

As a result of their action research involvement in the implementation of their own innovations in their own classrooms, teachers' attitudes toward and perceptions of research, development, and evaluation do become more positive. Moreover, they display an increased self-confidence for inquiry and self reflection on activities in their own classrooms. These teachers develop stronger feelings of personal professionalism in that they come to appreciate the importance of their own capabilities and professional responsibilities for identifying and making the curricular and instructional changes (reforms) needed to move our educational system toward the stature of world-class quality. Thus, teachers can become more deeply immersed in a challenging and increasingly complex profession. We suggest that institutionalizing action research into teacher preparation programs and into the activities of practicing teachers benefits both educational research and the teaching profession because of the opportunities to:

• view educational problems from teacher and teaching perspectives.

• inform classroom practice in order to improve teaching and learning.

• eliminate traditional hostilities and the distrust of teachers for researchers, and vice versa.

• enroll those directly involved in attempts to solve classroom problems.

Partnership — I

A partnership, based on equality and shared responsibility between teachers on the one hand and scientists and engineers in university, business, or industry on the other, offers another route towards enhancing the professional status of teachers. This conclusion is emerging from two NCSTL pilot projects — one that matches middle school science teachers with faculty at The Ohio State University, and one that studies development of linkages between elementary schools and the private sector. The major goals of both studies has been to identify common characteristics among successful partnerships and to develop guidelines for partnership replication. In this section we shall describe

briefly the middle school program and in the next section the elementary program.

There are several problems facing science education at the middle school level. These include:

- insufficient funds to incorporate equipment-oriented teaching units into the classroom.
- administrative school structures that limit the classroom flexibility so often vital for successful science units.
- isolation of science trained teachers due to their small numbers at this educational level.
- insufficient opportunities for teachers to keep up with the latest developments in content of and teaching methods for the various sciences.

NCSTL has developed a partnership program that provides awards to science specialist middle school teachers. These awards provide support for the design and implementation of new curricular units by those teachers. Included are: i) \$1000 for the sole use of the participating teacher and \$250 for discretionary use by the administration in support of any science education effort in the building; ii) room and board expenses for the participating teacher to attend three meetings at the NCSTL; and iii) pairing of each participant with an appropriate science or technology expert from a university — in most cases Ohio State. The criteria specified for these new curricular units are that they be: i) for grades 5-8; ii) 6-10 weeks in length; iii) integrated into current curriculum; iv) assessed according to a specified plan; and v) supported by the school administration (e.g., through additional financial support, administrative participation, provision of teacher release time, etc.).

We observed the following results from this partnership program:

- useful and creative science curriculum units were conceived, designed, developed, and implemented in the classroom within one year in almost all cases.
- teachers who were in the buildings where the participants were located but who were not a part of the original group often became actively involved.
- the participants' professional status, as perceived by others and by the participants themselves, was enhanced.

The last of these observations was particularly striking and was evidenced by: participants who were recipients of special teacher awards during that school year; one teacher's reassignment from a basement room to more appropriate classroom space for science at an upper level; the successful effort by participants at one school to modify the school day schedule so as to accommodate interdisciplinary teaching and learning needs; successful acquisition by some teachers of additional grant funds from other outside sources; reassignment of teaching staff to better utilize

science experience and expertise of teachers; participants approached by other teachers to provide help in such areas as grant proposal writing or new unit development.

Our speculations on the relationship of the partnership program to these outcomes are:

- The teachers felt that selection for participation and funding by a major university, Ohio State, and a national research center, the NCSTL, brought their efforts to the attention of their administration and colleagues.
- Positive reactions and a focus of attention on science teaching came from press releases placed in local papers describing the award winners and the nature of their participation in the partnership program.
- Significant changes became possible because of building administrator support actively encouraged through special efforts of the Program Directors to include the principals in the partnership activities.
- The award of discretionary funds to the teachers and the challenge of developing units based entirely on their own perceived classroom needs and utilizing their own expertise appear to have energized the teachers to look at their roles in new ways.

Although our work is still preliminary, our research concerning partnerships shows that the greatest advantage in such relationships may lie not with the outside resources *per se*, or with the curriculum which is produced within the classroom, but with the changes in teachers' perceptions of themselves. Apparently, when middle school teachers receive financial resources for which they (not an administrator) are responsible, and when they have collaborative interaction with content experts, they perceive that their professional status is enhanced, a self perception that we can hope will also enhance their performance. This perception coupled with the changes that schools make in response (e.g., restructuring the school schedule to accommodate the suggestions and curriculum reform efforts of teachers) may help to establish a newly won professional status and to empower teachers. Changing the role of the teacher may in turn bring about more stable institutionalized reform.

Thus, there is a tentative conclusion with practical consequences. The apparent success of this project to date suggests that some of the funds currently being spent by local, state, and federal agencies on in-service workshops should be invested into direct awards and partnership support systems for teachers. It may be both cost efficient and effective to complement the in-service workshop injection of content by also providing direct support to teachers who at their discretion introduce their own curricular improvements.

American business supports community educational and human services ... Business has both an important civic duty to support public education and good business reasons to do so. Many business leaders see their stake as consisting of a steady flow of qualified workers, a working populace that buys goods and services, and community goodwill that supports business.³

The business community has shown an interest in providing individuals and resources in the attempt to catalyze needed change in local schools and in the community and state policies that impact upon science education. One might expect such interest, especially now that workers will need new knowledge and skills for adapting to new technologies, work methods, and markets. One way to involve business in education is the school/business partnership, which has potential benefits for both partners. For the schools these benefits include: informing students, teachers, and administrators of work place needs; providing schools with additional human and material resources; providing students and teachers opportunities to participate in work place experiences; introducing teachers to new knowledge and skills brought by the business partner; and providing additional community support. For business/industry there are the opportunities: to work with a student population that will constitute both future work force and consumer; to participate directly in and thereby influence the educational process that helps mold our nation's future; and to establish interest in the communities within which they operate.

It is, therefore, not surprising that school/business partnerships are being established in numerous school districts and communities. Regardless of their popularity, however, there appears to be little documentation of successes and failures outside of the anecdotal stories ending with the observation of how wonderful the experience has been for everyone. For this reason the NCSL has been observing partnerships between elementary school teachers and individuals from businesses in the Columbus, Ohio area. These partnerships, sponsored by the Science and Mathematics Network of Central Ohio, have been based on the premise that school/business partnerships can and should introduce into the participating schools both the impetus and the means to effect science and mathematics education reform. With this as the working premise, there were a number of questions prompting the study.

- How do successful partnerships form in terms of structure and administration?
- What do the participants of the partnership see as advantages for their participation?
- What defines a successful partnership?
- What if any benefits accrue to student learning?
- Are any substantive changes observed within the school?

- What if any impact does the relationship have on the business?
- How are the participants in such partnerships affected by the experience?
- Can such partnerships further positive changes in science education?

It is still too early to draw definitive conclusions from this study. However, we would argue tentatively that effective partnering will need: deep commitment, which includes the willingness to invest sufficient resources, on both sides; careful planning with meaningful input into all aspects of the joint project from all individuals involved in the partnership; and a clear understanding between both parties of the motives and goals that each brings into the relationship. We have also observed that innovative practice and content may result from the partnership and that participants from both sides have derived strong personal satisfaction from the effort.

Factors Related to Perception of Teaching as a Profession

Because the action research and partnership projects we have described so briefly are still unfinished, the observations drawn from them remain to be refined. Nonetheless, it may be profitable to consider a possible relationship between the support services and incentives these three research programs provided teachers and the potential for change in teachers' professional status within the educational system. The following is a list of these services and incentives, although each item on the list was not included in all three programs.

- a forum for teachers and others to share ideals, ideas, concerns, problems, solutions, successes, and failures related to the efforts to improve teaching and learning.
- funds for teachers to use at their discretion for instructional and professional development needs (e.g., projects, materials, field trips, technology, services, meetings).
- ready access to local, state, and national communication systems (e.g., E-mail, data processing systems, networks, bulletin boards, 1-800 numbers) for teachers.⁴
- ready access to print materials, video equipment, manipulative, software, technology (e.g., calculators, computers, VCR, cameras) for use in science instruction.
- ready access and support for science teachers from professionals/experts (e.g., science, technology, science education, research).
- opportunities to interact and collaborate on a regular

basis with other teachers at the same and at different grade levels.

- institutional support available to the school building (principal) to encourage and facilitate teacher innovation and inquiry.

- flexibility in school scheduling within the day, the week, the term, and the year so as to be adaptable to special curricular needs.

- a social and professional support systems of peers and collaborators (e.g., teachers with teachers, teachers with university faculty, teachers with corporate America).

- public recognition and commendation of educational programs and teachers (e.g., newspaper, video, and television coverage).

- letters of commendation of teachers to principals, superintendents, supervisors, and school boards.

- publicly expressed appreciation for the capabilities and responsibilities of professional educators.

- customized professional development opportunities for teachers.

- especially designed university graduate programs and courses for teachers.

- opportunities for graduate student teaching, graduate student research, and study leave of absence support for teachers.

- encouragement, assistance, and incentive to teachers in seeking outside funding for improvement of science teaching and learning in their classrooms.

The questions we shall continue to pose will deal with whether and how these various factors do contribute to changing both public attitudes and perceptions of science teachers and science teachers own self-perception. But we must all be aware also of other important unanswered questions.

- How do we provide teachers with the time and motivation necessary to reflect and to apply their professional expertise?
- How can we provide even the most rudimentary communication technology, such as telephones and modems, to teachers, in an age when technology is commonplace in most business and professional offices?
- How do we develop and arrange for flexible scheduling and alternative schooling experiences that would allow teachers' the in-depth studies of their students in their particular area of interest and expertise?

- How do we build "community" among teachers, parents, students, decision-makers (e.g., legislators, business and industry, work force representatives, administrators)?

- How do we best communicate to the public a realistic view of what teachers need related to what is expected of them by society?

- How do we best inform the public about the value and needs of teachers?

- How do we develop an effective community support system?

Administrators, teachers, parents, scientists, science educators, representatives of the corporate world, policy makers, decision-makers, and the public should all participate actively in the educational system and should work to obtain the resources, incentives, and respect for teachers that their task requires and deserves. The NCSL is committed to the continuation of research into the factors that influence the status of the teaching profession. We hope that each of you will join in and contribute your perceptions and expertise to this effort. For significant, long-lasting reform in our complex social, economic, political, and academic educational system requires attention from us all.

Notes

1 Fowler, C. (1992) "One nation, undercultured and underqualified," *American Music Teacher* 41(4), 30-81.

2 White, R. T., and Tisher, R. P. (1986) "Research on natural sciences," in M. C. Wittrock (Ed.), *Handbook of Research on Teaching Third Edition* (Macmillan Publishing Company, New York, NY) pp. 874-905.

3 Carnegie Council on Adolescent Development (1989) "Turning points: Preparing American youth for the 21st century." (Carnegie Corporation of New York, NY) p. 76

4 NCSL in cooperation with the School Science and Mathematics Association and support from the National Science Foundation provides the opportunity for teachers of science and mathematics to network with other teachers, faculties of higher education institutions, business and industry representatives, and local community members. This activity helps to develop and maintain a cadre of science and mathematics advocates with a strong commitment to and expertise in science and mathematics education. It also strengthens the links between administration, teachers, and the technology experts in business and industry.